REMARKS

Claims 1-27 are pending in the present application.

In the office action mailed November 17, 2003 (the "Office Action"), claim 22 was rejected under 35 U.S.C. 102(e) as being anticipated by U.S. Patent No. 6,175,368 to Aleksic *et al.* (the "Aleksic patent"). Claims 1-9, 11, 13-15, 17-20, and 23-26 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Blinn, "Simulation of Wrinkled Surfaces" (the "Blinn reference") in view of the Aleksic patent. Claims 10, 16, 21, and 27 have been rejected under 35 U.S.C. 103(a) as being unpatentable over the Blinn reference in view of the Aleksic patent further in view of "Learning Alias Level One (the "Alias reference"). Claim 12 was rejected under 35 U.S.C. 103(a) as being unpatentable over the Blinn reference in view of the Aleksic patent further in view of Foley *et al.*, "Computer Graphics: Principles and Practice" (the "Foley reference").

Before discussing the rejection of the pending claims, the disclosed embodiments of the invention will now be discussed in comparison to the applied references in order to help the Examiner appreciate certain distinctions between the pending claims and the subject matter of the applied references. Specific distinctions between the pending claims and the references will be discussed after the discussion of the disclosed embodiment and the references. This discussion of the differences between the disclosed embodiment and the applied references does not define the scope or interpretation of any of the claims.

The present invention includes embodiments of a gradient mapping engine that is used to calculate a perturbed normal vector N' for use in bump mapping applications. As known in the art, the perturbed normal vector N' can be defined by adding a displacement D to a normal vector N, that is, N' = N + D. In conventional applications, the displacement is calculated per pixel using the following equation: $D = f_u(P_v \text{ X } N) + f_v(P_u \text{ X } N)$. P_u and P_v represent tangent vectors along the u and v axes, respectively, and f_u and f_v are the partial derivatives of an image height field f(u, v). However, in the embodiment of the gradient mapping engine, rather than calculate the displacement conventionally, the displacement is estimated using the following equation: $D = (f_u * P_v * scale_u) + (f_v * P_u * scale_v)$. Pu and Pv represent tangent vectors along the u and v axes, respectively, and f_u and f_v represent the derivative at a particular pixel having coordinates (u, v). The f_u and f_v values can be bilinearly filtered values obtained by iterating

coordinates (bu, bv) of the bump map, which the gradient mapping engine receives from a triangle engine. The scaleu and scalev values are scalar values that are used to adjust the magnitude of the perturbed normal N'. Using the displacement estimation described above, a perturbed normal N' is determined.

The Blinn reference describes a method of modeling the appearance of surface irregularities through the use of a perturbed normal vector. A perturbed vector results from a normal vector displaced by a small perturbation vector. The perturbed vector is then used in calculating the color of the pixel. That is, rather than using the normal vector for shading calculations, the perturbed normal vector is used instead. As a result, the surface appears to have surface irregularities. As described in the Blinn reference, the perturbed normal vector is the sum of the normal vector and a displacement vector: N' = N + D, where D = (Fu (N x Pv) - Fv (N x Pu), and where Fu and Fv represent the derivatives of the function F defining the surface irregularities with respect to u and v.

The Aleksic patent describes a system that provides bump mapping of an object with reduced overhead of conventional bump mapping techniques. Using bump map coordinates and physical display coordinates, two sets of bump intensity data are generated and stored in respective look-up tables ("LUTs"). Bump map coordinates are used by a coefficient determiner 22 to calculate first and second access coefficients. The first and second access coefficients are used as index values to access the LUTs to obtain first and second bump intensity values, 40 and 42, respectively. In calculating the first and second bump intensity values, the following variables are defined in the Aleksic patent:

u_i, v_i are bump map coordinates. See col. 5, lines 50-51.

Bu, Bv are axis coefficients for respective axes of the bump map, which are used to index the respective LUTs storing pre-calculated bump intensity values. See col. 8, lines 35-43.

fu, fv are vectors that correlate respective axes of the bump map to the plane of the object. The vectors are derived with respect to the fixed coordinate system of the display. See col. 5, lines 52-56.

(fu · L), (fv · L) are gradient intensities, where L is a light vector. See col. 5, lines 61-64.

$\Delta N \cdot L$ is the bump intensity value for a pixel, and is the sum of $B_u \times (fu \cdot L)$ and $B_v \times (fv \cdot L)$. See col. 4, lines 19-21 and col. 10, lines 39-41.

As described in the Aleksic patent, since the first and second axes of the bump map can be correlated to the fixed coordinates of the display space, the gradients of $(fu \cdot L)$ and $(fv \cdot L)$ can be calculated only once, rather than per-pixel as with the conventional approach. Using the respective calculated gradients, two sets of bump intensity values are calculated for a normalized range of coefficients B_u and B_v. The first bump intensity values are defined as $B_u \times (fu \cdot L)$ and the second bump intensity values are defined as $B_v \times (fv \cdot L)$. The plurality of pre-calculated bump intensity values $B_u \times (fu \cdot L)$ and $B_v \times (fv \cdot L)$ are stored in respective LUTs. Since the bump intensity values have already been calculated for normalized values of B_u and B_v, the specific B_u and B_v coefficients for a pixel are used as index values to access the sets of pre-calculated bump intensity values stored in the LUTs. The specifically selected bump intensity values $B_u \times (fu \cdot L)$ and $B_v \times (fv \cdot L)$ can then be summed to calculate a value representing the dot product of the bump vector ΔN and a light vector L. Thus, the operation of calculating bump intensity values merely involves a look-up operation and a summing operation. The bump intensity value $(\Delta N \cdot L)$ 44 is in turn combined with a normal shading function $(N \cdot L)$ to obtain a resulting shading function $(N + \Delta N)$. Consequently, the resulting shading function is the sum of the bump intensity value and a normal shading function, or $(N \cdot L) + (\Delta N \cdot L)$.

As previously mentioned, claims 1-9, 11, 13-15, 17-20, and 23-26 have been rejected under 35 U.S.C. 103(a) as being unpatentable over the Blinn reference in view of the Aleksic patent.

Claim 1 is patentable over the Blinn reference in view of the Aleksic patent. Claim 1 recites a method of altering color values of a pixel along a surface function having an interpolated normal vector, comprising adding a displacement vector to the interpolated normal vector to produce a perturbed normal vector, the displacement vector calculated from the equation: D = (fu * Pu * scaleu) + (fv * Pv * scalev), where D is the displacement vector, Pu and Pv are perpendicular vectors tangent to the surface function at the pixel, fu and fv are displacement values along Pu and Pv, respectively, and scaleu and scalev are scaling values, and generating color values for the pixel based on the perturbed normal vector instead of the interpolated normal vector.

The combined teachings of the Blinn reference and the Aleksic patent fail to teach or suggest the combination of limitations recited by claim 1. The Examiner has argued that the Blinn reference teaches adding a displacement vector to an interpolated normal vector to produce a perturbed normal vector, but fails to teach calculating a displacement vector using the equation: D = (fu * Pu * scaleu) + (fv * Pv * scalev). The Examiner cites the Aleksic patent as teaching the use of D = (fu * Pu * scaleu) + (fv * Pv * scalev) to calculate a displacement vector in order to make up for the deficiencies of the Blinn reference. However, the Aleksic patent, as previously discussed, teaches a system that can determine a shading function from the sum of a normal shading function ($N \cdot L$) and a bump intensity value ($\Delta N \cdot L$). In contrast to the combination of limitations recited in claim 1, the system described in the Aleksic patent never teaches calculating the perturbed normal, that is, using the notation of the Aleksic patent, ($N + \Delta N$) is never actually calculated by the Aleksic system. The system described by the Aleksic patent avoids the need to calculate the perturbed normal vector entirely.

As described in the Aleksic patent, the shadow function, which is ultimately the function trying to be obtained, is the dot product of a light vector L and the resulting (i.e., perturbed) vector, that is: shadow function = $L \cdot (N + \Delta N)$. The shadow function can be broken down into two components, a normal shading component ($N \cdot L$) and a bump-shading component ($\Delta N \cdot L$). As explained in the Aleksic patent, the normal shading component can be calculated once for the particular object, and the bump-shading component is calculated through substitution of first and second bump intensity values selected from a plurality of values stored in respective LUTs. That is, the bump-shading component can be broken down as $(\Delta N \cdot L) = B_u \times (fu \cdot L) + B_v \times (fv \cdot L)$, where $B_u \times (fu \cdot L)$ is the first bump intensity value and $B_v \times (fv \cdot L)$ is the second bump intensity value for respective axes of the bump map. Each of the LUTs stores a plurality of respective bump intensity values which are selected by using axis coefficients Bu, Bv of respective axes of the bump map as indices. The plurality of bump intensity values stored in the respective LUTs represent the gradient values ($fu \cdot L$) and ($fv \cdot L$) for normalized Bu and Bv values. Thus, calculation of the bump-shading component ($\Delta N \cdot L$) can be accomplished by accessing the two LUTs using the axis coefficients Bu, Bv to retrieve first and second bump-intensity values $B_u \times (fu \cdot L)$ and $B_v \times (fv \cdot L)$, and then summing the first and second bump intensity values. None of the calculations performed in the system described in the Aleksic

patent, however, are similar to solving for a displacement vector as recited in claim 1, namely, using D = (fu * Pu * scaleu) + (fv * Pv * scalev), where Pu and Pv are perpendicular vectors tangent to the surface function at the pixel, fu and fv are displacement values along Pu and Pv, respectively, and scaleu and scalev are scaling values.

The material in the Aleksic patent cited by the Examiner does not teach calculating a displacement vector as recited in claim 1. The parameters to the equation described in the Aleksic patent are not the same as those recited in claim 1, and as a result, the equation described in the Aleksic patent cannot be the same. For example, the first and second bump intensity values $B_u \times (fu \cdot L)$ and $B_v \times (fv \cdot L)$ are calculated using a light vector L, a parameter that is not used in the calculation of the displacement vector as recited in claim 1. Moreover, a mere substitution of parameters into the equation described in the Aleksic patent will not result in calculating the displacement vector as recited in claim 1. The result of the equation described in the Aleksic patent is a bump intensity value. In contrast, the equation recited in claim 1 provides a displacement vector. Contrary to the Examiner's characterization, the equation described in the Aleksic patent does not anticipate the displacement vector equation recited in claim 1.

For the foregoing reasons, claim 1 is patentable over the Blinn reference in view of the Aleksic patent. Therefore, the rejection of claim 1 under 35 U.S.C. 103(a) should be withdrawn.

Claims 6, 11, 17, and 23 are also patentable over the Blinn reference in view of the Aleksic patent. Claim 6 recites a method for altering color values of a pixel having a normal vector normal to a surface in which the pixel is located, the method comprising calculating the color values for the pixel based on a perturbed normal vector having a displacement from the interpolated normal vector, the displacement equal to a first vector tangent to the surface at the location of the pixel scaled by a first scale factor and a first displacement value, and a second vector tangent to the surface at the location of the pixel and scaled by a second scale factor and a second displacement value, the second vector perpendicular to the first vector.

Claim 11 recites a method for providing surface texture in a graphics image, comprising determining a normal vector for a pixel having a location along a surface, adding a displacement vector to the normal vector to produce a perturbed normal vector, the displacement vector calculated from the sum of a first vector tangent to the surface at the location of the pixel

scaled by a first scale factor and a first displacement component, and a second vector perpendicular to the first vector and tangent to the surface at the location of the pixel and scaled by a second scale factor and a second displacement component, and calculating color values for the pixel based on the perturbed normal vector instead of the normal vector.

Claim 17 recites a computer graphics processing system for calculating color values of pixel having a location along a surface, comprising a gradient mapping circuit to calculate for the pixel a perturbed normal vector displaced from a normal vector normal to the surface at the location of the pixel by a displacement vector, the displacement vector equal to the sum of a first vector tangent to the surface at the pixel scaled by a first scale factor and a first displacement component, and a second vector tangent to the surface at the pixel and scaled by a second scale factor and a second displacement component, the second vector perpendicular to the first vector. Claim 23 recites a computer system having a computer graphics processing system as recited in claim 17.

The combined teachings of the Blinn reference and the Aleksic patent fail to teach or suggest the combination of limitations recited by the respective claims. As previously discussed with respect to claim 1, the Aleksic patent does not make up for the deficiencies of the Blinn patent because it does not teach using a estimated displacement vector as recited in the claims. The equation described in the Aleksic patent does not use the same parameters as recited in the claims and is directed to solving a different value. Simply put, the bump intensity values that are calculated using the equations in the Aleksic patent are not the same as the displacement vector recited in the claims.

For the foregoing reasons, claims 6, 11, 17, and 23 are patentable over the Blinn reference in view of the Aleksic patent. Therefore, the rejection of claims 6, 11, 17, and 23 under 35 U.S.C. 103(a) should be withdrawn.

Claims 2-5, which depend from claim 1, claims 7-9 which depend from claim 6, claims 13-15, which depend from claim 11, claims 18-20, which depend from claim 17, and claims 24-26, which depend from claim 23, are similarly patentable over the Blinn reference in view of the Aleksic patent based on their dependency from a respective allowable base claim. That is, each of the dependent claims further narrows the scope of the claim from which it depends, and consequently, if a claim is dependent from an allowable base claim, the dependent

claim is also allowable. For the foregoing reasons, the rejection of claims 7-9, 13-15, 18-20, and 24-26 under 35 U.S.C. 103(a) should be withdrawn.

As previously mentioned, claims 10, 16, 21, and 27 have been rejected under 35 U.S.C. 103(a) as being unpatentable over the Blinn reference in view of the Aleksic patent, and further in view of the Alias reference. Claim 12 has been rejected under 35 U.S.C. 103(a) as being unpatentable over the Blinn reference in view of the Aleksic patent, further in view of the Foley reference. Each of these claims depend from a respective allowable base claim, and are consequently patentable as well. Moreover, the Alias and Foley references fail to make up for the deficiencies of the combined teachings of the Blinn reference in view of the Aleksic patent, as previously discussed with respect to claims 1, 6, 11, 17, and 23. For the foregoing reasons, claims 10, 12, 16, 21, and 27 are patentable over the Blinn reference in view of the Aleksic patent, and further in view of the Alias and Foley references. Therefore, the rejection of claims 10, 12, 16, 21, and 27 under 35 U.S.C. 103(a) should be withdrawn.

Finally, as previously mentioned, claim 22 has been rejected under 35 U.S.C. 102(e) as being anticipated by the Aleksic patent. Claim 22 recites a computer graphics processing system for calculating color values of pixels representing a surface, comprising a gradient mapping circuit to calculate for each pixel a value representative of a displacement vector having first and second perpendicular components, the first component equal to the product of a first vector tangent to the surface at the pixel, a first scale factor, and a first displacement component along the first vector, and the second component equal to the product of a second vector tangent to the surface at the pixel, a second scale factor, and a second displacement component along the second vector.

The Aleksic patent fails to teach the combination of limitations recited in claim 22. For example, the Aleksic patent fails to teach a gradient mapping circuit calculating a displacement vector using the parameters recited in claim 22. As previously discussed with respect to claims 1, 6, 11, 17, and 23, the equation described in the Aleksic patent for calculating a bump intensity value is not the same as for calculating a displacement vector as recited in the claims. For the foregoing reasons, claim 22 is patentably distinct from the Aleksic patent, and consequently, the rejection of claim 22 under 35 U.S.C. 102(e) should be withdrawn.

All of the claims pending in the present application are in condition for allowance. Favorable consideration and a timely Notice of Allowance are earnestly solicited.

Respectfully submitted,

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